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## ORIGINAL MEMOIRS.

### THE USE OF ETHYL CHLORIDE AS A GENERAL ANÆSTHETIC IN THE PENNSYLVANIA HOSPITAL.\*

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DR. CHARLES F. MITCHELL, in the winter of 1902, first used ethyl chloride for general anæsthesia in the receiving ward of the Pennsylvania Hospital, and it proved so satisfactory for short light anæsthesias that it was introduced into the general surgical wards and there used for minor operations and painful surgical dressings. Dr. Francis O. Allen, when Resident Anæsthetist, first used it in combination with ether and chloroform during the early part of 1903.

There are now records of its use in 5575 cases during the period commencing December, 1902, and ending June 1, 1908, as follows: Alone, in 947; with anesthol, in 47; with anesthol and ether, in 391; with ether, in 4148; with scopalamine and morphia, in 1; with chloroform, in 2; and with intraspinal injections of stovaine, in 39.

The youngest patient was 24 hours old and the oldest 84 years. The lengths of the anæsthesias have varied from several seconds to 54 minutes. The average dosage for 3 minutes has been 10 grammes.

\* A preliminary report read before the Philadelphia Academy of Surgery, June, 1908.

Bengue's preparation of ethyl chloride was first used, but it was soon found that an American product known commercially as antidolorin was just as satisfactory and the latter has been used in practically all of the cases.

Several of the many forms of closed and semiclosed inhalers devised for its administration have been tried and abandoned for gauze. If a prolonged anæsthesia is desired or the ethyl chloride is to be followed by another anæsthetic, the patient should have the usual anæsthetic preparation; otherwise, it may be given without this preparation. Lying in the supine position the patient is told to breathe quietly, close the eyes and prepare for sleep. Upon several layers of wide mesh gauze, held from 6 to 8 inches from the face, the anæsthetic is slowly dropped. As the patient becomes drowsy the dose is increased and the gauze brought closer to the face and with the loss of consciousness, the gauze, 4 to 8 layers thick, is placed over the mouth and nose and the ethyl chloride given with the spray. Sometime before the loss of consciousness the patient is anæsthetic to very severe pain and many minor operations requiring but a few minutes may be done in this stage. Frequently in this stage there is a respiratory arrest, especially if the anæsthetic has been given too rapidly or too concentrated, but with its continued administration the respirations are resumed becoming slower and deeper. With the progress of the anæsthesia the eyeballs begin to roll and the pupils partially dilate when the patient enters the second stage, in which there is deep anæsthesia without, however, much muscular relaxation and with, frequently, considerable muscular rigidity and spasm. Progressing still further the eyeballs become fixed, the pupil widely dilated and immobile, the corneal reflex disappears and the face is flushed and covered with perspiration. This is undoubtedly the danger-line beyond which the respirations become insidiously shallower with consequent deepening cyanosis, there may be an external squint of the eyeballs and frequently muscular rigidity and spasm or as rarely occurs general relaxation. The fatalities seem to be due primarily to respiratory and secondarily to cardiac failure.

Large and Brown, in their experiments on dogs, seem to have confirmed the clinical observations that there is always a fall of blood-pressure, which in a few cases may be preceded by a temporary rise, and their explanation of the respiratory failure is that it is due to a paralysis of the respiratory centre produced possibly by the lowered blood-pressure.

When ether is to follow the ethyl chloride it is gradually introduced drop by drop upon the same gauze at the period when the patient loses consciousness and while its dosage is rapidly increased, the ethyl chloride is gradually withdrawn. If, however, a sudden change is made from the ethyl chloride to the ether, the patient will in the majority of cases recover from the ethyl chloride intoxication before that of the ether appears. It is the feeling in the hospital that with this slow induction requiring from 2 to 3 minutes, the gradually increasing dosage and the free admission of air allows a more careful observation of the progress of the anæsthesia and a timely recognition of the danger-line, and when one remembers that with large concentrated doses and a closed inhaler a patient can be carried beyond this line in from 8 to 20 seconds this will be understood, also with this method we do not have the frequent occurrence of muscular spasm, post-anæsthetic vomiting and headache so strongly emphasized by those using the closed method.

Safety is undoubtedly the first consideration in the use of any anæsthetic and though ethyl chloride has been used since 1847 and very generally used in England and on the continent since 1897 there is still a great difference of opinion as to its mortality. Hewitt places it between ether and chloroform with an estimated mortality of 1-10,000 and in the latest edition of his book quotes McCardie's figures of 1-3000. Luke makes one estimate of 1-8000 and a few months later 1-150,000. Each of these men have had personal experience in over 2000 cases without any fatalities. Herrenknecht reports 3000 cases without a mishap.

Such varied difference of opinion, Hawley suggests, would indicate that there may be other elements present, indepen-

dent of the anæsthetic itself, to cause death, and a careful analysis of the reported fatalities seems to support this suggestion. There are recorded in literature in a rather imperfect way some 21 cases which have been collected by Luke, and to these we now add 4 more. Another fatal case reported by Dr. Allen is case No. 3 in this list.

In view of Hawley's suggestion an analysis of these cases is very interesting.

Case 2 was a 12-months-old child with diphtheritic laryngeal obstruction.

Case 5 was a large healthy man 24 years of age with a huge submaxillary abscess. Several minutes after the removal of the anæsthetic and after the abscess had been opened, respirations stopped so suddenly as to suggest that there was some acute laryngeal obstruction. At least four minutes later a tracheotomy was done without the reëstablishment of respiration. The autopsy showed marked œdema of the glottis with a relaxed fold of the mucous membrane over the abscess wall "which might have been" sucked into the small air-passage of the glottis.

Case 6, a male 67 years old, whose autopsy showed a very large mass of malignant cervical glands encroaching upon the lumen of the pharynx and larynx and involving the vocal cords.

Case 3, reported by Dr. Allen in 1903, was a colored man 28 years of age with an incarcerated hernia. He had been vomiting freely but the vomitus was not fecal in character, otherwise his condition was good. During the change from ethyl chloride to ether he suddenly recommenced vomiting and brought up large quantities of a clear fluid. This lasted three to four minutes, after which respirations were not resumed. An examination by the surgeon failed to show any pharyngeal or laryngeal obstruction and he considered it an anæsthetic death. There was no autopsy.

Case 22.—Ethyl chloride was chosen as the anæsthetic for a negro 17 years of age, with an acute ischio rectal abscess, because of a harassing cough, profuse expectoration and signs of a chronic consolidation of the left lung. He was placed in the lithotomy position, and though never deeply anæsthetized, received considerably more than the usual ten grammes for the anæsthesia

extended over a period of more than 15 minutes. Ten or fifteen minutes after the withdrawal of the anæsthetic there was a violent paroxysm of coughing, after which the respirations ceased and were not reëstablished with vigorous stimulation, artificial respiration and tracheotomy. The pulse in this case continued beating for some time after the respiratory arrest. At the post-mortem examination the whole left lung was found to be involved in a tuberculous consolidation with a small cavity in the apex; there was a tuberculous pericarditis with a large amount of fluid in the sac and a tuberculous peritonitis.

Case 23.—A negro 30 years old, while attempting a highway robbery one week previous to his admission to the hospital, received a load of buckshot in the lower part of the left axilla. He had remained in hiding all this time without medical attention and when he entered the hospital there was a large gaping wound in the lower portion of the left axilla and the physical signs of a general peritonitis and profound sepsis. While being placed upon the operating table his pulse became imperceptible and after receiving less than a gramme of ethyl chloride given in the usual way and before any operative procedure could be commenced his respirations gradually ceased. The autopsy showed a large wound of the left pleura and an empyema of the same pleural cavity; a wound and empyema of the pericardial cavity; a wound of the diaphragm; perforations of the stomach and intestines and a purulent peritonitis.

Case 24.—D. H., an unmarried negress, 30 years of age, was being treated in the medical wards for *Adiposa Dolorosa* and developed a Ludwig's Angina, associated with marked laryngeal obstruction. Incisions beneath the jaw opened the sublingual tissues and allowed a few drops of pus to escape. When the patient was placed in the dorsal position the laryngeal obstruction was considerably increased and after receiving about 5 grammes of ethyl chloride given in the usual way her respirations stopped, the pulse remaining unaffected, but with the removal of the anæsthetic and artificial respiration they were quickly resumed. Twenty-four hours later, the œdema and the laryngeal obstruction having increased, another operation was attempted and as before the respiratory obstruction was greatly increased by the dorsal position and after receiving about a gramme of ethyl chloride it became complete and was never reëstablished,

though a quick tracheotomy was done. The autopsy showed acute inflammation and œdema of the pharyngeal, sublingual and cervical tissues with œdema of the glottis.

Case 25.—A young married negress with the diagnosis of tubo-ovarian abscess was given an unknown quantity of ethyl chloride preliminary to a proposed ether anæsthesia. After taking the anæsthetic for one or two minutes the respirations suddenly ceased and though the pulse could be felt for a short time after the respirations had stopped it soon disappeared and cardiac stimulants together with artificial respirations produced no effect. There was no postmortem examination and a physical examination made just before the anæsthetic was given was negative except for the presence of a loud systolic heart murmur without any signs of lost compensation.

Seven of these fatalities recorded in the literature occurred during dental operations and the anæsthetic was given by the dentist or his assistant. In eight cases the patients were in the upright position when the ethyl chloride was administered. In seven cases where the method is recorded a closed or semi-closed inhaler was used 3-6 c.c. of the ethyl chloride being sprayed at once into the bag and given to the patient.

The occurrence of several deaths under anæsthesia at Guy's Hospital is the cause for an editorial in the *Hospital*, London, in which anæsthetic deaths are carefully considered. During the period of 6 years from 1901 to 1907 there occurred at Guy's 36 deaths under anæsthesia; in another hospital 31 in 85,000 anæsthesias, and in still another 7 in three years. And it raises the question of whether it is right to credit all of the operative deaths which occur under anæsthesia to the anæsthetic when the surgeon wishing to give the patients every possible chance will operate upon them when almost moribund. It also criticizes the compiling of statistics from various hospitals and thus estimating mortalities.

With these criticisms in mind we have reviewed the records of all the anæsthesias given in the hospital during this same period of five and a half years. They were administered by

the Resident Anæsthetizers and Resident Physicians. Squibb's ether was used in practically all of these cases. In a very few, during the early part of the period, the anæsthetics were given with an Allis inhaler, in all of the remaining ones the gauze and drop method was employed.

There have been 5575 cases in which ethyl chloride has been used as a general anæsthetic and during the administration of which 5 cases died. The ethyl chloride was used alone in 947 times and all of these deaths occurred while it was being used in this way and none when used in combination with other anæsthetics, ether, chloroform, or anesthol, of which there were 4628. The fact that the ethyl chloride was given first and to all the cases which were considered bad anæsthetic risks distorts these statistics:

Ether was given 5592 times and during its administration 3 deaths occurred. As with the ethyl chloride all of these deaths occurred while it was being used alone in 1444 cases, one as the operation was begun, the other two near their completion.

An agent which may in 15-20 seconds produce deep anæsthesia and whose danger-signs are so easily passed cannot be used with impunity, and a few of the reported fatalities certainly demonstrate its danger in inexperienced hands. Another objection to its use is the muscular spasm and rigidity which occurs especially in alcoholics and very frequently in others. This, however, may be overcome more or less by the preliminary use of morphia and atropine and by following the ethyl chloride with ether.

Its advantages, on the other hand, are very tempting. For the patient there is no irritation of the respiratory tract with its usual coughing, increased secretions, gagging and vomiting; and therefore no respiratory struggle so often seen in ether and chloroform anæsthesia. The rapid onset of unconsciousness is not to be overlooked and its advantage will be appreciated by any who have taken ether patiently for 6 to 10 minutes. And most important the usual amount of ether necessary for the induction of anæsthesia to the third stage is

eliminated and as this averages four ounces with the open drop method the excretory organs are saved a considerable task. In our experience it certainly lessens the occurrence of post-operative vomiting.

To the anæsthetist the ease and rapidity of induction with complete elimination of the preliminary stages of ether and chloroform speaks for itself.

Though the mortality with ethyl chloride in this series of cases, is apparently greater than that of ether it is still being used in the hospital for (*a*) minor surgical procedures where a short anæsthesia of a few seconds to five minutes is desired; (*b*) the dressing of the more painful surgical wounds, such as the removal of abdominal packs; (*c*) and in combination with ether and chloroform.